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The changing face of neurosurgery for the older person

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Abstract

Increased life expectancy and illness prevention and treatment has led to a growing population of older patients. These changes in patient population are apparent in neurosurgery, however relatively little is reported about specific outcomes and prognostication in this group. This review summarises the challenges and management changes occurring in the treatment of three common neurosurgical pathologies; aneurysmal subarachnoid haemorrhage, head injury and haemorrhagic stroke. A move towards less invasive neurosurgical techniques has implications on the risk-benefit profile of interventions. This creates the opportunity to intervene in older patients with greater co-morbidity, as long as improved outcomes can be evidenced. A critical part of assessing appropriateness for surgical intervention in older patients may be to change from a mindset of age to one of frailty and growing interest in scales assessing this may aid treatment decisions in the future.

Keywords: Elderly, frailty, neurosurgery, subarachnoid haemorrhage, trauma.

Introduction

Increased life expectancy, lower operative morbidities and enhanced expectations from patients and their families, has led to an increasing population of older patients with pathology that may be amenable to neurosurgical treatment.

In 2010, Chibbaro showed that the proportion of patients aged 70 and over admitted to a Parisian neurosurgical unit increased from 11% in 1983 to 25% in 2007 [6]. Surgical interventions also increased from 77% to 93% in this group, with a particular rise in brain tumour surgery. Such trends are set to continue and a recent report from a UK regional neurosurgical centre showed continued increases in elderly admissions from 2000-2013, particularly in emergency conditions such as traumatic head injury and spontaneous subarachnoid haemorrhage [42].

An important driver of increased admission is the perceived improvement in outcomes in older patients. Chiabbaro showed a dramatic drop in the immediate mortality rate, from 12% to 0.3% in older patients [6]. Shifting treatment algorithms, such as endovascular coiling rather than aneurysm clipping, account, in part, for improved outcomes in larger numbers of patients. However, poor outcomes still prevail in older patients with emergency presentations: Whitehouse reported 5-year mortality of around 55% in neurosurgical patients over 65 admitted as an emergency compared with less than 20% in elective patients [42]. Mortality is particularly increased within 6 months of neurosurgical treatment and therefore surgical approaches and their associated complications need to be carefully considered to improve outcomes.

In this review we consider changes in practice and current treatment outcomes in older patients with aneurysmal subarachnoid haemorrhage, traumatic head injury and haemorrhagic strokes. We focus on the assessment of frailty in older patients and how this can help inform future treatment planning.

Aneurysmal subarachnoid haemorrhage

Incidental, unruptured cerebral aneurysms pose a risk of rupture over time; factors including size and location influence this risk [43]. It is logical, that as people live longer there is a greater lifetime risk of incidental aneurysm rupture and presentation with a subarachnoid haemorrhage (SAH). Conversely, first detection of an incidental cerebral aneurysm in later life means that there is reduced effect of any preventative treatment due to the deceased remaining life expectancy in the elderly. In addition, the outcomes, in terms of quality of life and mortality, from treated aneurysmal SAH in older patients is variable. As such, it is important that we have robust data on all these aspects, to guide management of both ruptured and unruptured aneurysms in the older person.

In 2006 Nieuwkamp et al reported outcomes in 170 patients aged ≥75 years presenting with aneurysmal SAH, where only 20% of patients were clipped and 8% coiled [27]. Overall, half the patients died and only 1 in 6 returned to independent function by discharge. Of their 60 patients admitted in a poor condition, (those with a Glasgow Coma Score of 12 or less), none were independent at discharge. The strongest predictor of poor outcome in good-grade admissions was re-bleeding. Compared to younger SAH patients, those aged 75 and over were more likely to be female (perhaps due to greater life expectancy) and suffer with medical complications and hydrocephalus. The authors suggested that early treatment of patients in a good condition may prevent re-bleeding and thus improve outcomes.

In 2013 Scholler analysed 265 patients over the age of 60 with aneurysmal SAH, with 36% aged between 70-79 and only 10% over 80 [33]. Challenges identified in this older population included increased co-morbidities (92% had at least one), the use of anti-thrombotic drugs (in 29%) and treatment of hydrocephalus with EVD which was more prevalent in those aged 70-80 years old (77%) compared to the 60-70 year old group (61%). Interventional treatment was undertaken in 85% of cases, with clipping in 48% and coiling in 37%, the latter more commonly in those aged over 80. Outcome was clearly associated with age; death or poor outcome at discharge occurred in 73% of over-70 year olds compared with 51% of 60-70 year olds. Condition at presentation was also important with no poor grade at presentation patients (WFNS 4-5) aged over 80 experiencing a good outcome at discharge. It is important to note that although 70% of conservatively managed patients died, none were

due to re-bleed, suggesting that it is the nature of the initial bleed and not any failure to treat, that results in the poor outcome.

There has also been a significant shift in practice in the last 15 years towards coiling, rather than clipping since the International Subarachnoid Aneurysm Trial (ISAT) [25]. Subsequent sub-group analysis of patients aged 65 years and over, suggested a trend towards better outcomes with endovascular treatment compared to clipping, although this was subject to aneurysm location [30]. Lower rates of infectious and pulmonary complications and epilepsy occurred in the endovascular group. This was supported by the Barrow Ruptured Aneurysm Trial (BRAT) which showed significantly poorer outcomes at 1 year in patients over 50 years old treated with clipping [21]. A recent systematic review of endovascular treatment of ruptured aneurysms in patients aged over 65 reported good outcomes in 66%, with a mortality rate of around 26%, at 1 year [36]. With an 86% complete or near complete occlusion rate at long-term follow-up, endovascular treatment is preferred to clipping and probably reduces risks for these older patients.

Koffijberg (2011) analysed the cost effectiveness of treating ruptured aneurysms in patients aged over 70, identifying key parameters including patient age (and thus life expectancy), good or poor clinical condition on presentation, conservative or occlusive treatment (clipping or coiling) and good or poor outcomes [18]. Perhaps surprisingly, occlusive treatment of aneurysms translated into a health benefit for all older patients presenting within 4 days of SAH, regardless of good or poor condition at presentation. A later presentation, particularly 10 days or more after SAH, was more likely to result in no or minimal treatment benefit. However, occlusive treatment was only found to be cost-effective in women aged 70-79, and men aged 70-74 presenting in a good condition, within 4 days of SAH. Thus, although potentially offering some clinical benefit, occlusive treatment is clearly more costly than conservative management and may be particularly difficult to justify in those aged 80 years and over presenting in a poor condition. It is, however, also important to highlight that studies assessing interventions such as this will contain inherent selection bias, by virtue of the fact that the patients undergoing intervention differ from those that were not. Such results should be treated with caution until clear, prospective, evidence is available.

It is apparent that patients presenting in a poor condition and aged over 70, are likely to have a poor outcome, and a conservative approach may be appropriate in some of these patients. More prospective research is needed to understand the risk-benefit profile of treating well patients, particularly those over 80 years of age. The current literature supports active intervention for those under this age, with an awareness of the increased risks of complications, but more data is needed specifically in relation to outcomes with endovascular intervention.

Head injury

The vast majority of older patients admitted to a neurosurgical unit with head injury have a subdural haematoma, most commonly chronic subdural haematoma (CSDH), followed by mixed and then acute subdural haematoma (ASDH) [41].

A CSDH is a condition almost exclusively confined to the elderly, with a median age of 77 in the UK [4]. The post-traumatic pathophysiology is complex; it takes weeks to months for the collection of blood and fluid to expand: evidences supports the theory that this is, in part, due to an escalating inflammatory process [8]. Many patients have no recollection of significant trauma. Patients usually present with cognitive impairment, gait disturbance, limb weakness or headache. The mainstay of treatment has been surgical drainage [4, 31]. However, recent trials have focused on medical treatments, such as steroids, for controlling the inflammatory response in CSDH, and therefore either reducing CSDH recurrence following surgery or even as a first-line treatment [9, 15, 19, 24]. Any treatment which reduces CSDH recurrence has the potential to reduce mortality, which can be as high as 18% at 6-months [31]. The outcome of these steroid trials is still awaited, but a move to more conservative treatments of CSDH could benefit older patients with multiple co-morbidities who are at increased risk from anaesthesia and surgical treatment.

ASDHs are traditionally considered to occur in higher impact trauma, leading to coma and hence a poorer prognosis, particularly in the elderly. However, due to co-existent cerebral atrophy in older patients and the lower energy forces (falls) causing most traumatic brain injuries in this age group, the onset of neurological deterioration secondary to an ASDH may be delayed. This provides an opportunity for definitive management, following an early CT

scan, as recommended by NICE guidelines [26]. ASDH following a minor fall is often exacerbated by the fact that nearly 2/3 of these patients are on an anti-thrombotic medications [20]. The increased use of these medications and an aging population are probably contributing to growing rates of ASDH in the elderly. A recent review of 165 ASDHs in a German hospital reported 41.2% of them occurring in patients aged 80 or over [44]. Importantly, although 90% of the patients aged ≥80 years of age underwent surgery, only 24% experienced a favourable outcome at discharge (Glasgow outcome scale 4-5), increasing to 36% at 3-months. The mortality rate was high, 48% at 3 months, and predictors of an unfavourable outcome included >5 co-morbidities, GCS ≤ 8 at admission and 24 hrs, re-bleeding and pneumonia. Use of anti-thrombotic medications at presentation is also clearly a risk factor for poor outcome in all patients [45]. Another series reported no survivors in patients with an ASDH aged over 90 and only 1/8 survivors in those aged over 65 with a GCS less than 10 at presentation [41]. A recent systematic review of ASDH in the elderly reported on only 7 eligible studies with the mean patient age ranging from 73-85 years [10]. Outcomes varied with a mortality rate ranging from 27-70%, and a good functional outcome in 10-41% but with a presenting GCS ≤ 8 representing a poor prognostic factor. However, overall the studies were classified as low quality and were particularly lacking in assessments of patient frailty which may aid future research in this field. It is clear that poor neurology from the outset is associated with poor outcome, however as the incidence of this pathology appears to be increasing in older patients, effective surgical decision-making tools are needed. In patients over 80 years old, with multi-morbidity and poor neurology caution should be applied, however it could be advocated that in all other circumstances surgical treatment should at least be considered. Attempts have been made at producing scoring systems to aid prognostication in elderly patients with ASDH, but more widespread validation of this is required [1].

It is notable that several large scale studies assessing interventions for severe traumatic brain injury (TBI) in general, including decompressive craniectomy [7, 16], ICP monitoring [5] and cooling [2], have either excluded older patients or had minimal older patients included. Whilst this makes understanding treatment in this age group challenging, it may also just be a reflection of the reality that fewer older patients are considered likely to survive intervention. This is supported by collaborations such as IMPACT (International Mission for Prognosis and Analysis of Clinical Trials in TBI) and CRASH (Corticosteroid Randomisation After

Significant Head injury), who have used available evidence to develop prognostic calculators for TBI, where age is a core stratifying component and significantly increases chances of a poor outcome [17, 38]. Overall, it is recognised that a lack of evidence has led to varying practices and understanding about interventions for TBI in older patients, but it is clear that functional and cognitive recovery is significantly worse in this age group [13]. Understanding patient baseline function and morbidity is important but recognising the high chance of a poor outcome in this age group often leads clinicians to follow a conservative route, avoiding neuro-intensive care.

Surgical management of haemorrhagic stroke

Intracranial haemorrhage (ICH) in older people is often the result of long-standing underlying pathological vascular disease. A patient therefore presents with intracranial pressure effects and focal neurological deficits associated with the ICH as well as the systemic co-morbidities of cardiac, peripheral vascular disease and often the use of anti-thrombotic medications. Furthermore, there are always risks of secondary haemorrhage.

The STICH I and II trials did not demonstrate any overall benefit from early surgery compared with initial conservative management for supratentorial (including lobar) ICH. [22, 23]. The median patient age for STICH I was 62 years (IQR 52-70) and 65 years (IQR 55 to 74) for STICH II. The inference from these studies is that surgeons are already appropriately undertaking selective, targeted surgery to the patients that are most likely to benefit from it. When there is equipoise about whether to operate, these studies suggest it is reasonable to manage the patient conservatively in the first instance and then re-assess.

More recently there has been a move towards minimally-invasive surgery (MIS) for ICH, with the potential benefits of being less traumatic, quicker and more focused than a craniotomy. However, controversy exists concerning the widespread clinical application of such techniques. A recent meta-analysis (2018) on MIS for hypertensive ICH (the most common cause of spontaneous ICH), reported a positive effect on patient prognosis (using GOS) compared to both craniotomy and conservative treatment [37]. Mortality rates were lower for MIS compared to conservative treatment and post-operative re-bleeding rates were lower for MIS compared to craniotomy. As this review only included 8 randomised controlled trials and most studies also excluded patients that were >80 years old, more high-

quality studies and in a wider population of older patients are needed before firm conclusions can be drawn. This is particularly important as recent reviews have showed that 29-34% of patients diagnosed with an ICH are ≥80 years old, and this patient group has significantly higher rates of in-hospital mortality and unfavourable outcome [3, 35].

Scaggiante (2018) also published a meta-analysis of MIS, assessing 15 RCTs that mainly deployed endoscopic and/or stereotactic thrombolytic techniques [32]. This consolidated the finding that MIS improved outcome compared to both craniotomy and conservative treatment. Different MIS techniques (endoscopy and stereotactic thrombolysis) both showed significant improvements, but these techniques have not been compared directly. Earlier MIS evacuation of an ICH appeared to be associated with a better chance of achieving functional independence. Conversely, the final results of the MISTIE 3 (Minimially Invasive Surgery with Thrombolysis in ICH Evacuation) trial showed that aspiration and thrombolytic irrigation of an ICH with alteplase via an image directed catheter did not improve functional outcomes compared with standard care for large ICHs [14]. A modest survival benefit was identified. This trial only included patients aged 52 to 71 years old, so caution must be exercised in applying the conclusions to older patients.

Frailty scales

The comprehensive geriatric assessment (CGA) is an established tool used to assess the needs of older people and implement investigations and treatments to improve long-term outcomes. Use of this tool has been shown to improve post-operative outcomes in older patients undergoing elective surgery across specialties [28]. It is therefore clear that older people have different needs, which when identified and addressed can improve outcome. The CGA is a robust but cumbersome assessment including 6 different domains (medical, mental health, functional capacity, social circumstances, environment and risk score). Identification of simpler tools, possibly even specific to neurosurgery, are necessary. Understanding what is meant by frailty is also important, as, although there is some cross-over with disability and co-morbidity, it actually refers to a physiological state of increased vulnerability to stressors due to decreased physiological reserve [12].

A frailty score based on the assessment of data from 27,098 cranial neurosurgical cases has been reported, where higher scores had good sensitivity and specificity for predicting

increased 30-day mortality [39]. The score considered 19 predictors of mortality, with the most significant including ascites, ventilator dependency and renal failure, alongside more common problems such as anti-hypertensive medication use, high white cell count and low body mass index. The disadvantages are that this score still contains a relatively large number of variables and requires prospective evaluation. Tools such as the modified Frailty Index (mFI), that have already been well validated in surgical populations, may be more useful [11, 40]. Youngerman reviewed 9,149 patients with brain tumours and found increased higher mFI scores were associated with increased mortality, severe neurological complications and prolonged length of stay [46]. Combined assessment of mFI, age and ASA (American Society of Anaesthesiologists) classification gave the best predictive ability on overall outcome. A simpler scale, the clinical frailty scale, has also been applied in neurosurgical patients, predicting prognosis in operated CSDH [29, 34]. Frailty has also been correlated with poor outcome in older patients with aneurysmal SAH, however this was a very simplistic assessment of frailty based on haemoglobin, albumin and BMI [47].

Standardised assessments of frailty are needed, with validation in large cohorts of neurosurgical patients across a range of pathologies. This may then support the development of prognostication tools and aid clinical decision making and family discussions.

Conclusion

At what point we consider a person to be "elderly" is shifting, as patients are fitter and more independent until later in life. There have also been several neurosurgical advances which may preferentially benefit older patients with multiple comorbidities such as endovascular coiling, medical treatment of CSDH and MIS surgery for ICH. Patients aged over 65 years of age certainly do benefit from acute neurosurgical interventions, but there is more uncertainty and risk for those aged over 80. An age cut-off itself may not be helpful, but rather frailty should be considered instead, and we advocate improved reporting of this metric in future trials and studies. Most importantly, given the lack of robust evidence, determining patient eligibility for intervention is often left to the treating clinician. Whilst it is always possible to intervene, it is not always appropriate and a significantly lower likelihood of maintaining quality of life in older patients for the conditions discussed must be recognised. On the other hand, a therapeutic nihilism may be deterministic and thwart development of improved clinical practice in this group of patients.

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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